



KAIYO Cruise Report

KY14-04

Construction of DONET2 system
and Development of long-term observation using Nankai
seafloor boreholes

Kumano-nada

Mar.04, 2014-Mar.27, 2014

Japan Agency for Marine-Earth Science and Technology
(JAMSTEC)

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1. Cruise Information

- Cruise ID KY14-04
- Name of vessel R/V KAIYO
- Title of this cruise Construction of DONET2 system and Development of long-term observation using Nankai seafloor boreholes
- Title of proposal Construction of DONET2 system
Development of long-term observation using Nankai seafloor boreholes
- Cruise period March 4 – March 27, 2014
- Ports of call SHI Yokosuka Works - SHI Yokosuka Works
- Research area Kumano Nada, Off Kii-Channel
- Research Map

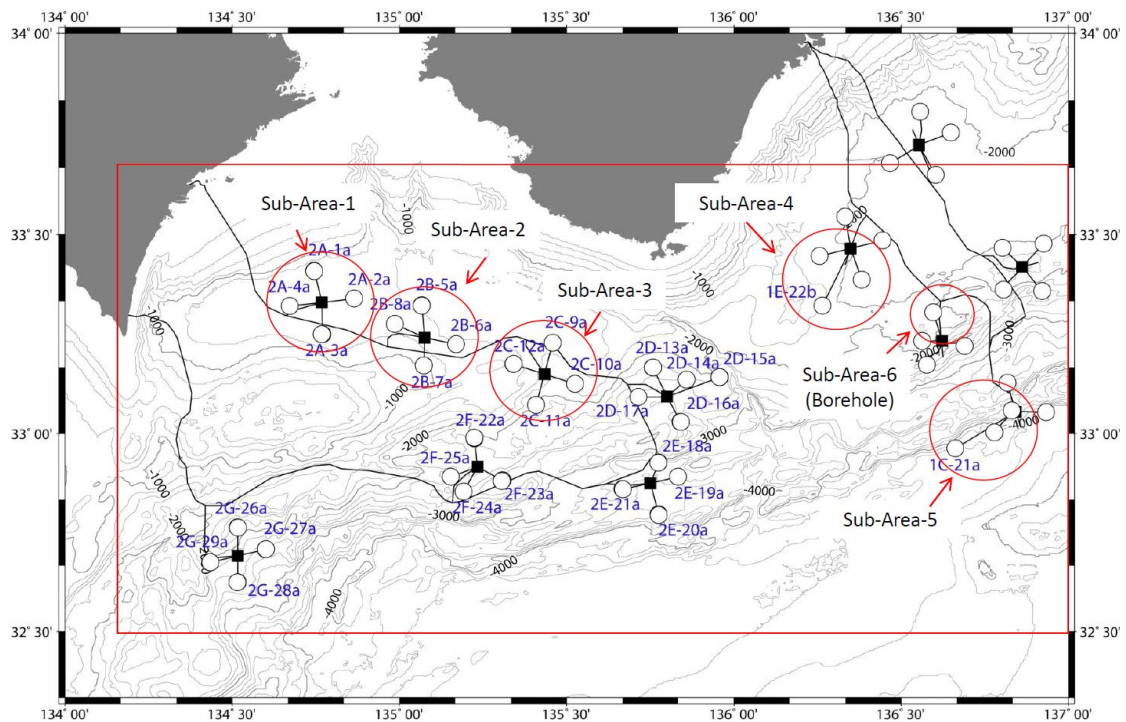


Figure 1.1 Research area and sub-area

2. Science Party

- Chief scientist: Takashi Yokobiki [JAMSTEC]
- Representative of the science party: Yoshiyuki Kaneda [JAMSTEC]
Eiichiro Araki [JAMSTEC]
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Shuhei Nishida [JAMSTEC]
Jin-Kyu Choi [JAMSTEC]
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Sho Kaneko [NGK]

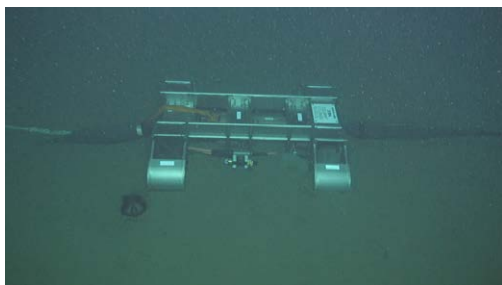
3. Background

Development of the first DONET system started in 2006, in order to research the large scale real-time observation in Nankai Trough using dense ocean-floor sensor network. This system consists of three major components; the backbone cable system, the science node, and the measurement instrument. The electric power and the communication channels are provided to the underwater equipment through the high reliability backbone cable system that is developed based on submarine telecommunication cable systems. The science node is the device with the role of hub and electric power distributor. The measurement instruments are composed of precision seismometer and pressure gauge to observe small or large earthquakes, slow-slip events on the plate boundary, and tsunamis. The measurement instrument is connected to the science node with the extension cable that is laid on the sea bed using ROV. These components brings to DONET system three key features; Redundancy, Extendable, and Replaceable of the measurement instruments. The first DONET system deployed off Kii Peninsula has been operating with the 250km backbone cable, 5 science nodes and 20 observatories since August 2011. The second DONET project named DONET2 is composed of 320km backbone cable, 7 science nodes, 29 observatories and 2 additional observatories of DONET1. The first laying operation of backbone cable system was carried out from January to February in 2014. In the laying operation, three terminal units in the northern section were installed. The remaining section will be installed in FY2014. The purposes of this expedition are construction of DONET2 to start operation of the observatory.

4. Dive Summary

4.1. DIVE #1625 Installation of the node at Area 2A on March 7

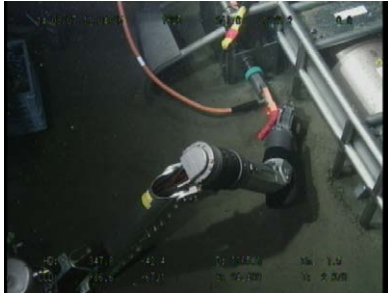
This dive is the first dive of the ROV “Hyper Dolphin” for DONET2 construction. In this dive, the node has been installed at Area 2A. After landing on the seafloor, the ROV moved toward the terminal unit installed by a cable ship and put the node on the seafloor near the terminal unit. Then, the ROV pulled the underwater mateable connector from the node and took it to the terminal for connection. After connection, we confirmed that the node is operated correctly. Fig. 4.1 shows the procedures of the installation operation. The position of the terminal is (33-19.8074N, 134-46.0794E, 1371m, ROV-Homer ID: 21) and the node is (33-19.8036N, 134-46.0729E, 1371m).



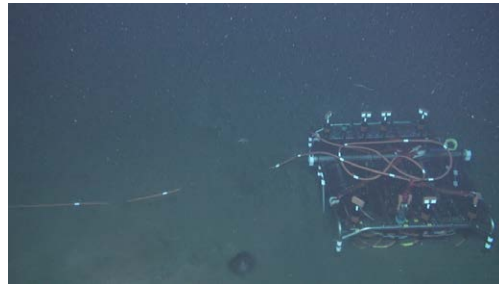
(a) Terminal unit



(b) The node installed on the seafloor



(c) Connection with the terminal

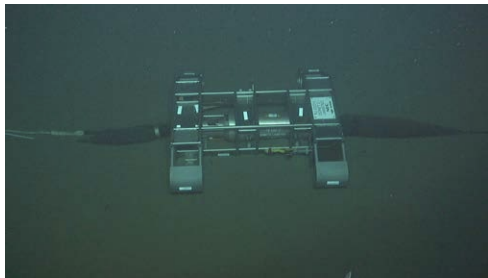


(d) After the connection

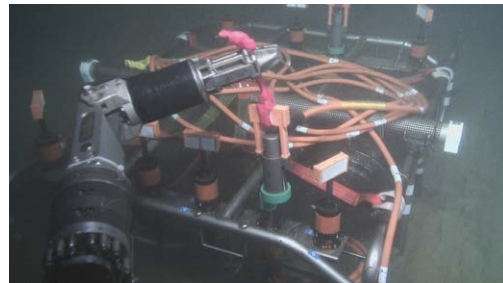
Fig. 4.1. Installation of the node at Area 2A.

4.2. DIVE #1626 Installation of the node at Area 2B on March 8

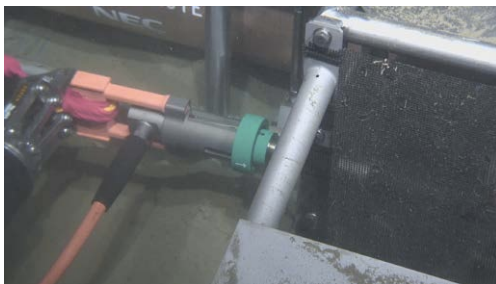
The node has been installed at Area 2B. After landing on the seafloor, the ROV moved toward the terminal unit installed by a cable ship and put the node on the seafloor near the terminal unit. Then, the ROV pulled the underwater mateable connector from the node and took it to the terminal for connection. After connection, it was confirmed that the node is operated correctly. Fig. 4.2 shows some photos taken during the installation operation. The position of the terminal is (33-14.4948N, 135-04.4847E, 1294m, ROV-Homer ID: 22) and the node is (33-14.5035N, 135-04.4838E, 1294m).



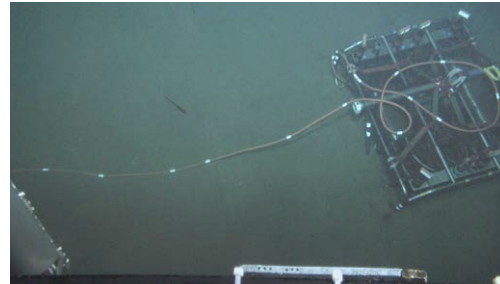
(a) Terminal unit



(b) The node installed on the seafloor



(c) Connection with the terminal



(d) After the connection

Fig. 4.2. Installation of the node at Area 2B.

4.3. DIVE #1627 Installation of the node at Area 2C on March 9

The node has been installed at Area 2C. The ROV first moved toward the terminal unit installed by a cable ship and put the node on the seafloor near the terminal unit. The ROV then pulled the underwater mateable connector from the node and took it to the terminal for connection. After connection, it was confirmed that the node is operated correctly. Fig. 4.3 shows some photos taken during the installation operation. The position of the terminal is (33-08.9163N, 135-25.9927E, 1700m, ROV-Homer ID: 23) and the node is (33-08.9163N, 135-25.9841E, 1699m).



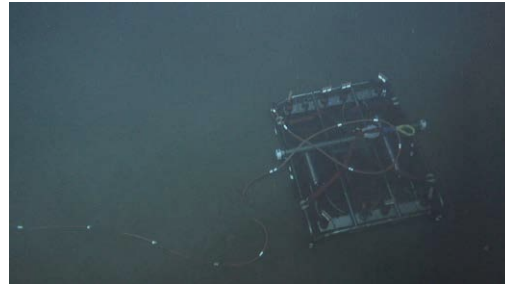
(a) Terminal unit



(b) The node installed on the seafloor



(c) Connection with the terminal

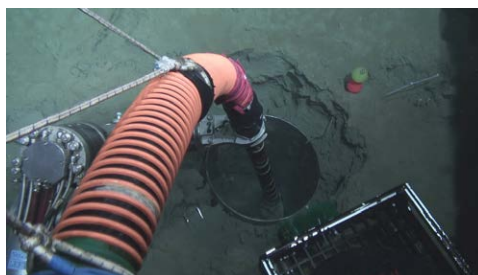


(d) After the connection

Fig. 4.3. Installation of the node at Area 2C.

4.4. DIVE #1628 2A-3b Sediment removal on March 10

In this dive, the tilting angle of the casing 2A-3b was first measured to make a decision whether or not it can be used for observatory installation. The tilting angle was confirmed to be less than 10 degree, this value is proper to be used. And then, the ROV removed the sediments inside the casing. The position of the casing 2A-3b is (33-14.9385N, 134-46.1496E, 1352m, ROV-Homer ID: 41).



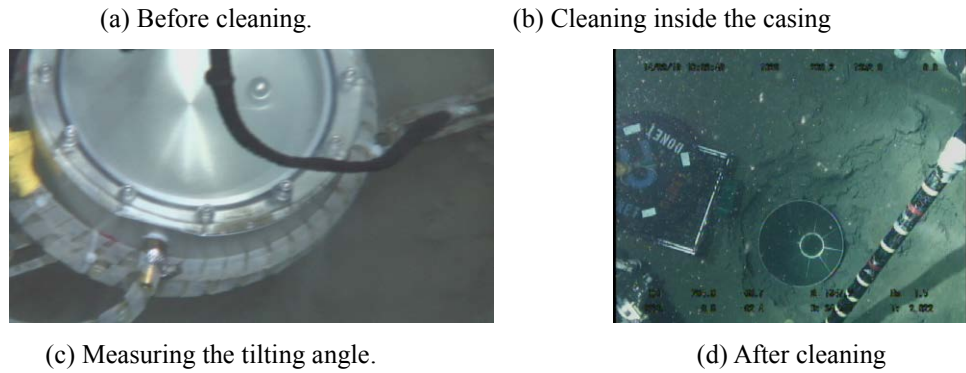


Fig. 4.4. Measuring the tilting angle and cleaning of the casing 2A-3b.

4.5. DIVE #1629 2A-3b Cable-laying operation on March 11

The cable-laying operation from the node 2A to the casing 2A-b was carried out using the automated cable-laying system developed by us. After landing on near the node, the ROV first put the underwater mateable connector linking to the forefront of the cable on the cable bobbin into the port 2 of the node (Fig. 4.5(a)). After that, the junction box was put on the seafloor (Fig. 4.5(b)). Then, the cable-laying operation was started (Fig. 4.5(c)); however, the transponders equipped on the ROV for positioning purpose were malfunctioned and we stopped the cable-laying operation; the cable bobbin was put on the seafloor (Fig. 4.5(d)). The 8741m cable was paid out, the traveled distance was 8350m, and the remained distance was about 520m (this distance was obtained from the ROV-Homer).

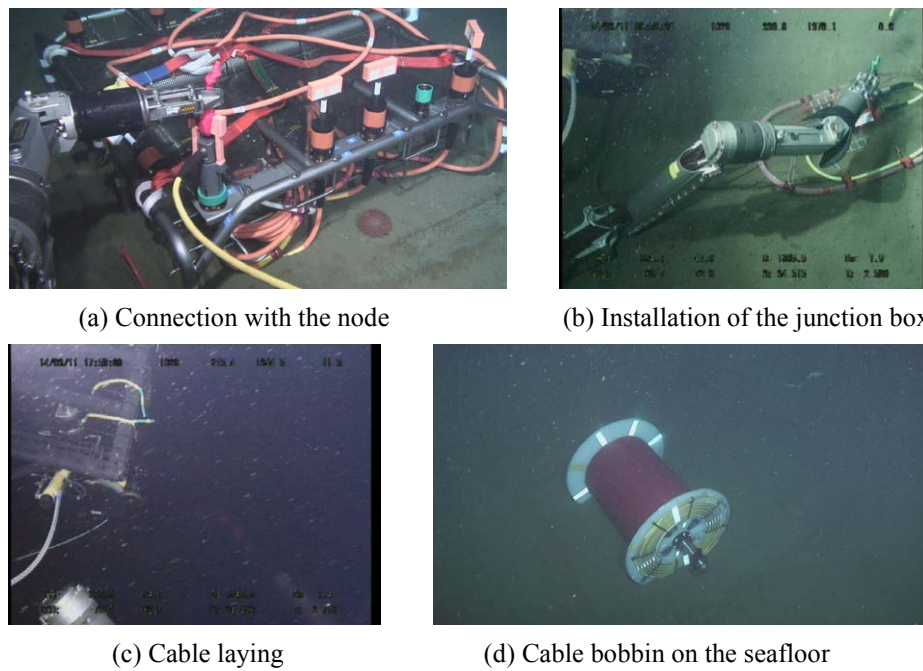


Fig. 4.5. Cable-laying operation from the node at Area 2A to the casing 2A-3b (1st laying).

4.6. DIVE #1630: Hyper Dolphin Maintenance Dive on March 12

This dive was executed to check the positioning system of Hyper Dolphin.

4.7. DIVE #1631: Checking the cable bobbin on March 14

In this dive, we checked the cable bobbin that was put on the seafloor in DIVE #1629. First we found the cable that was laid in DIVE #1629 and the ROV moved along to the cable and found the cable bobbin (Fig. 4.7(a)). After that, the ROV put the ROV-Homer (ID: 92) for positioning. The position of the cable bobbin was (33-15.2223N, 134-46.1418E, 1355m).



(a) Cable bobbin found



(b) ROV-Homer for positioning

Fig. 4.7. Search for the cable bobbin that was put on the seafloor in DIVE #1629.

4.8. DIVE #1632 2A-3b Cable-laying operation on March 15 (the remaining section)

We continued the cable-laying operation from the node at Area 2A to the casing 2A-3b. Using the response of the ROV-Homer (ID: 92), the ROV approached the cable bobbin and loaded up it to the automated cable-laying system using a winch (Fig. 4.8(a)). And then, the ROV started the cable-laying operation. The cable-laying operation was completed successfully. Fig. 4.8(b) shows the cable bobbin installed near the casing 2A-3b. The length of the dispensed cable was approximately 9299m and the traveled distance was approximately 8771m.



(a) Loading up operation of the cable bobbin.

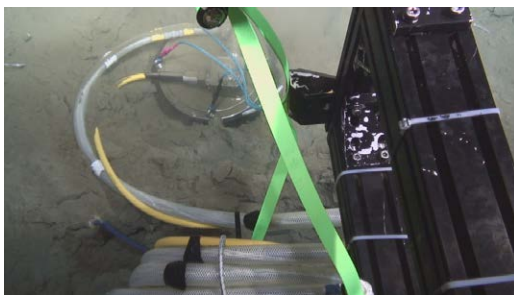


(b) Cable bobbin installed near the casing 2A-3b

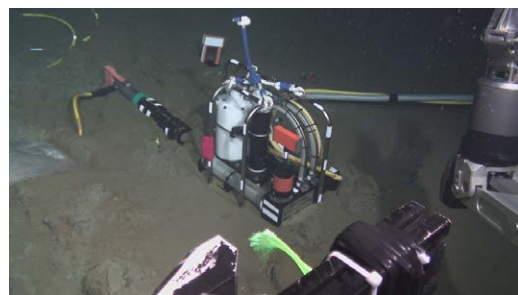
Fig. 4.8. Cable-laying operation from the node at Area 2A to the casing 2A-3b (continued).

4.9. DIVE #1633 Installation of the observatory at the casing 2A-3b on March 16

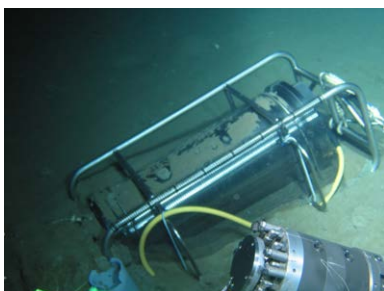
The observatory was installed at the casing 2A-3b in this dive. The observatory consists of a seismometer, a pressure sensor package, and battery equipment. First, the seismometer was installed inside the casing 2A-3b and then the pressure sensor package was put on the seafloor in a short distance from the seismometer. The battery equipment was put on the seafloor near the pressure sensor package. The cable on the cable bobbin, the seismometer, the pressure sensor package and the battery equipment were connected thorough cables. Before ascending, the ROV recovered the ROV-Homer (ID: 92) installed when DIVE #1631. This observatory is the first one of DONET2.



(a) Seismometer



(b) Pressure sensor package



(c) Battery equipment.



(d) After connection of all sensors

Fig. 4.9. Installation of the observatory at the casing 2A-3b.

4.10. DIVE #1634 Sediment removal (2B-5b) on March 17

The tilting angle of the casing 2B-5b was measured to make a decision whether or not it can be used for observatory installation. The tilting angle was confirmed to be less than 10 degree and the ROV removed the sediments inside the casing. The position of the casing 2B-5b is (33-19.3310N, 135-04.0000E, 1470m, ROV-Homer ID: 49).



(a) Before cleaning



(b) Measuring the tilting angle.



(c) After cleaning.



(d) The lid was put on the casing

Fig. 4.10. Measuring the tilting angle and cleaning of the casing 2B-5b.

4.11. DIVE #1635 Sediment removal (2B-6b) on March 17, 2014:

In this dive, the tilting angle of the casing 2B-6b was first measured to make a decision whether or not it can be used for observatory installation. The tilting angle was confirmed to be less than 10 degree. Then, the ROV removed the sediments inside the casing. The position of the casing 2B-6b is (33-13.5050N, 135-10.1821E, 1389m, ROV-Homer ID: 50).



(a) Before cleaning



(b) Measuring the tilting angle



(c) After cleaning.

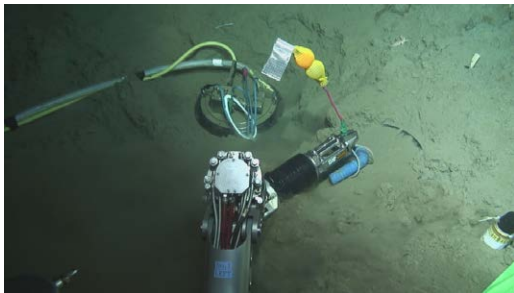


(d) The lid was put on the casing

Fig. 4.11. Measuring the tilting angle and cleaning of the casing 2B-6b.

4.12. DIVE #1636 Installation of the observatory at the casing 2B-5b on March 22

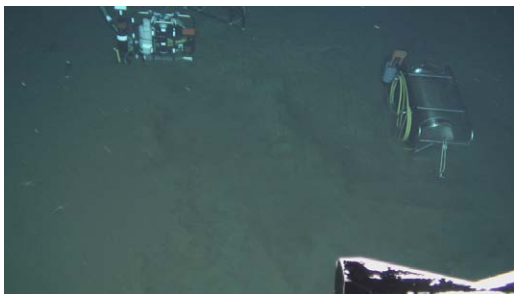
In this dive, the observatory was installed at the casing 2B-5b. The seismometer was first installed inside the casing 2B-5b and the pressure sensor package was then put on the seafloor in a short distance from the seismometer. The battery equipment was also put on the seafloor near the pressure sensor package. Lastly, the pressure sensor package and the battery equipment were connected using an underwater mateable connector.



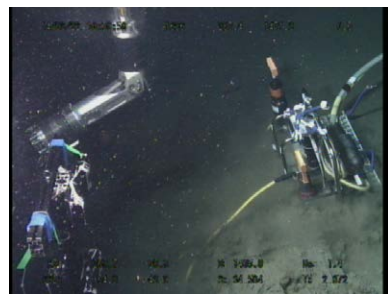
(a) Seismometer



(b) Battery equipment



(c) Sensor package and battery equipment



(d) Sensor package after connection with the battery

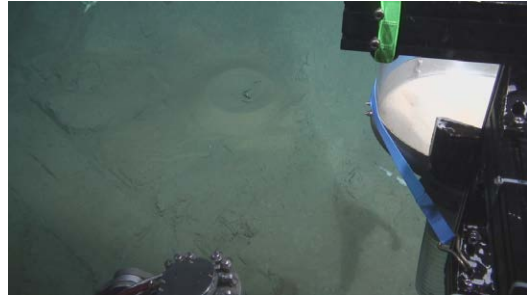
Fig. 4.12. Installation of the observatory at the casing 2B-5b.

4.13. DIVE #1637 Backfilling of the seismometer at the casing 2A-3 on March 23

In this dive, the seismometer installed at the observatory 2A-3 was backfilled by sands. Backfilling is conducted in order to reduce the measurement noise. Fig. 4.13 shows the photos of the seismometer before and after the backfilling.



(a) Before backfilling



(b) After backfilling

Fig. 4.13. Backfilling of the seismometer at the observatory 2A-3.

4.14. DIVE #1638 Sediment removal (2A-2b) on March 23

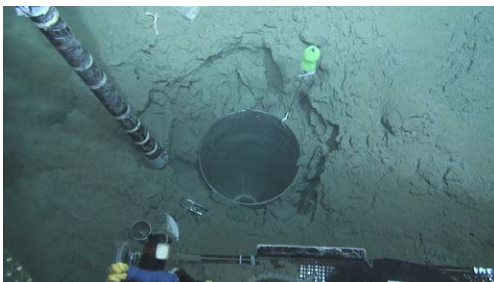
In this dive, the tilting angle of the casing 2A-2b was first measured to make a decision whether or not it can be used for observatory installation. The tilting angle was confirmed to be less than 10 degree. Then, the ROV removed the sediments inside the casing. The position of the casing 2A-2b is (33-20.3543N, 134-51.8466E, 1360m, ROV-Homer ID: 44).



(a) Before cleaning.



(b) Measuring the tilting angle



(c) After cleaning.



(d) The lid was put on the casing

Fig. 4.14. Measuring the tilting angle and cleaning of the casing 2A-2b.

4.15. DIVE #1639 Installation of the network seismometer at C0002G site on March 24

This dive was conducted at the IODP C0002G borehole observatory. The position of the C0002G observatory is 33°18.013N, 136°38.149E. This dive consists of the following two operations:

A) Installation of the network seismometer

In this dive, the network seismometer was installed in the seafloor near the C0002 observatory. First, data logger unit and battery unit was set onto the ROV platform of the C0002G observatory (Fig. 4.15.1). Then Underwater Mateable Connector (UMC) was connected to the borehole interface unit, which is connected to the DONET seafloor cable system (Fig.4.15.2). After the UMC connection, an extension cable was spread and then seismometer unit was stabbed into seafloor vertically (Fig.4.15.3) and tilt of the seismometer was checked by a tilt meter (Fig.4.15.4). After the installation, observed data was checked by land support scientist at the DONET1 FURUE land station.

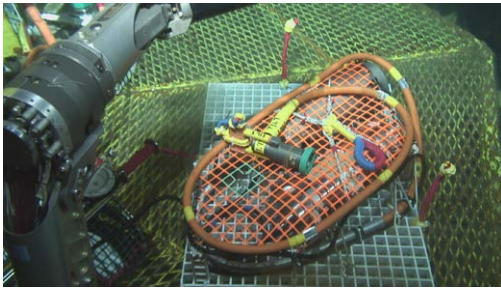


Fig.4.15.1 Data logger and battery unit

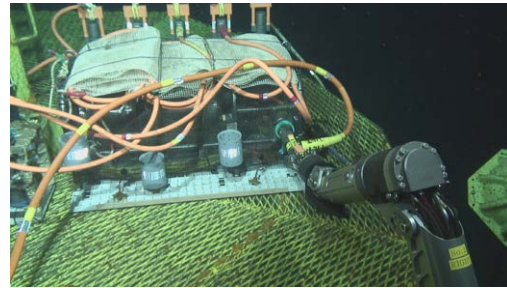


Fig.4.15.2 UMC connection



Fig.4.15.3 Seismometer installation



Fig.4.15.4 Leveling of the seismometer

B) Valve operation for calibration of borehole pressure meters

C0002G has three valves at the CORK head. Valves are used for the calibration of the pressure meters, measuring pore fluid pressure in the borehole. In this dive, calibration operation was conducted only for two valves, #1 and #2. The #3 valve is located at around the top of valve panel, and ROV manipulator was not reached. Each valve was rotated to clockwise with 180

degree to connect pressure port at the ocean floor, and after around 30 minutes, rotated to counter-clockwise with 180 degree to connect pressure port at the basement in the borehole (Fig.4.15.5).

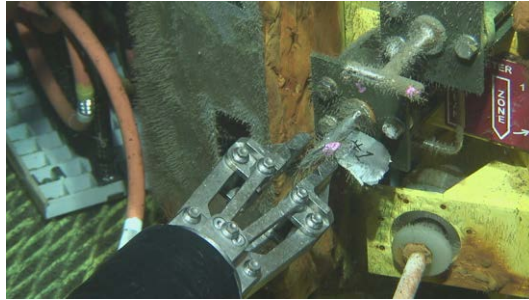


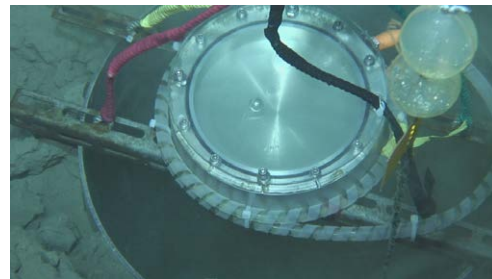
Fig.4.15.5 Valve operation

4.16. DIVE #1640 Sediment removal (2A-4b) on March 25

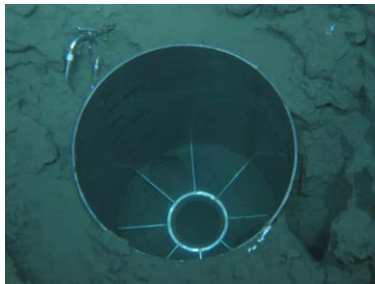
In this dive, the tilting angle of the casing 2A-4b was first measured to make a decision whether or not it can be used for observatory installation. The tilting angle was confirmed to be less than 10 degree. Then, the ROV removed the sediments inside the casing. The position of the casing 2A-4b is (33-19.2276N, 134-40.3225E, 1371m, ROV-Homer ID: 48).



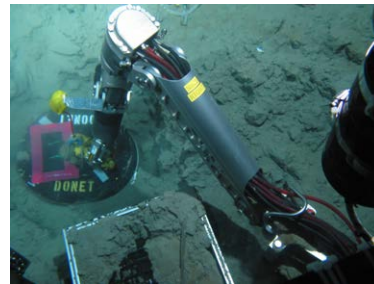
(a) Before cleaning.



(b) Measuring the tilting angle



(c) After cleaning.



(d) The lid was put on the casing

Fig. 4.16. Measuring the tilting angle and cleaning of the casing 2A-4b.

5 . Notice on Using

This cruise report is a preliminary documentation as of the end of the cruise.

This report may not be corrected even if changes on contents (i.e. taxonomic classifications) may be found after its publication. This report may also be changed without notice. Data on this cruise report may be raw or unprocessed. If you are going to use or refer to the data written on this report, please ask the Chief Scientist for latest information.

Users of data or results on this cruise report are requested to submit their results to the Data Management Group of JAMSTEC.